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AS5050 / AS5055

Programmable Magnetic Rotary Encoder

AS5050-AB-v1.1
Adapterboard

OPERATION MANUAL

1 VDD General Description

The AS5050/AS5055 is is a single-chip magnetic rotary encoder IC with low voltage and low power features.
It includes 4 integrated Hall elements, a high resolution ADC and a smart power management controller.
The angle position, alarm bits and magnetic field information are transmitted over a standard 3-wire or 4-wire SPI interface to the host processor.

The absolute angle measurement provides instant indication of the magnet's angular position with a resolution of:

- AS5050: 0.35° = 1024 positions per revolution
- AS5055: 0.09° = 4096 positions per revolution

The AS5055 is available in a small QFN 16-pin 4x4x0.85mm package and specified over an operating temperature of -20 to +85°C.

2 The AS5050/AS5055 Adapter board

2.1 Board description

The AS5050/AS5055 adapter board is a simple circuit allowing test and evaluation of the AS5050/AS5055 rotary encoder quickly without building a test fixture or PCB.
The PCB can be attached to a microcontroller or to the AS5050/AS5055-DB Demoboard as external device.

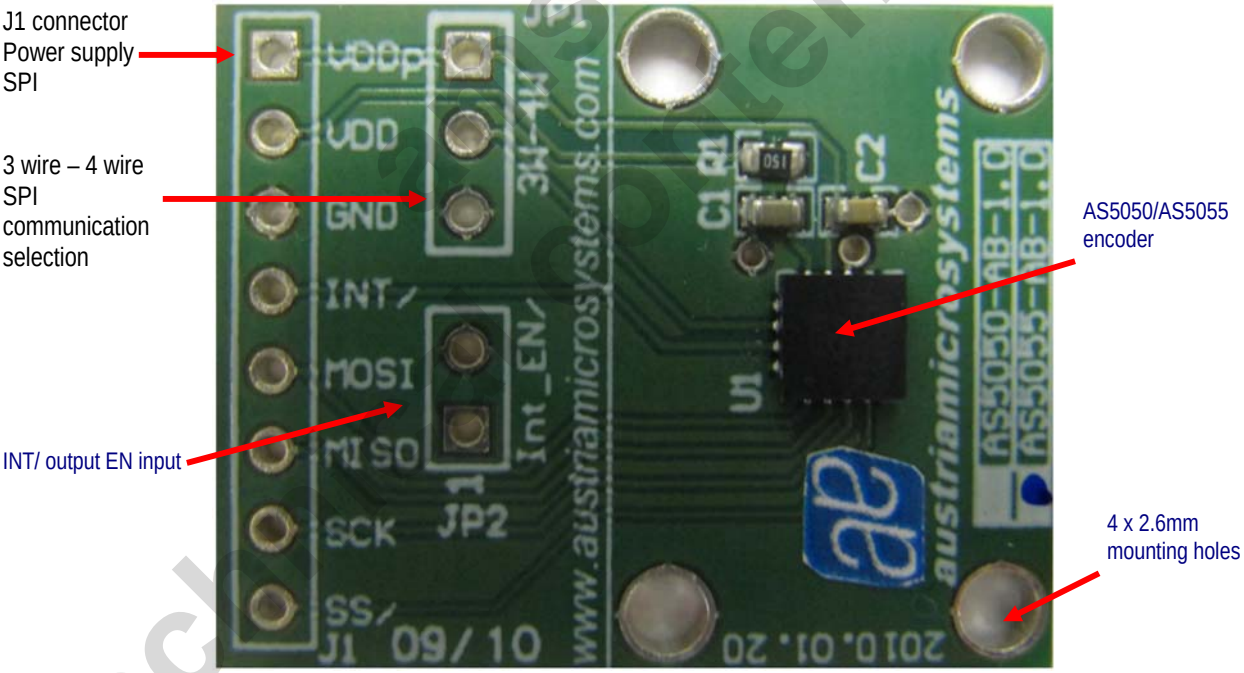

Figure 1: AS5050 Adapterboard

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2.2 Mounting the AS5050 adapter board

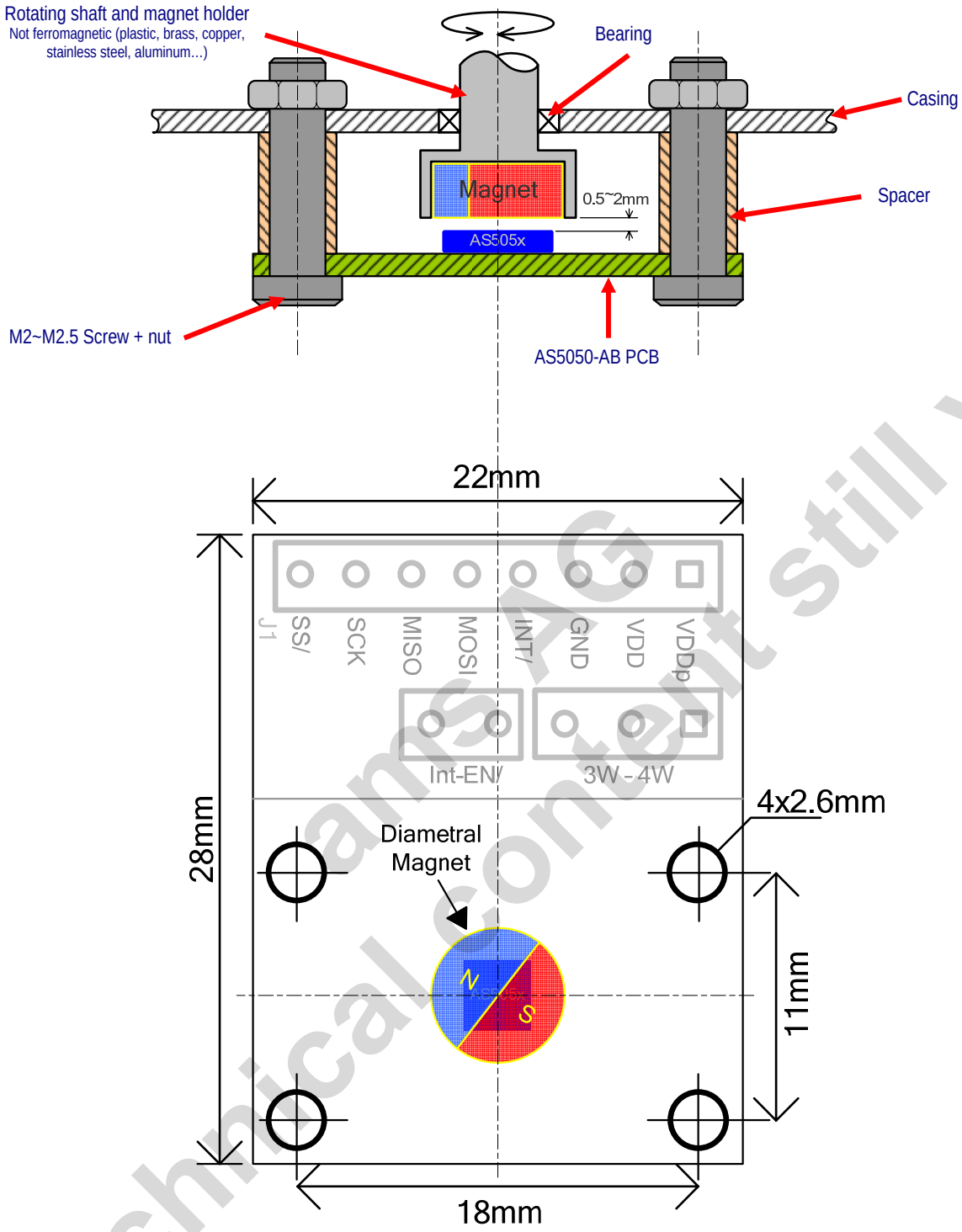

Figure 2: AS5050 adapter board mounting and dimension

A diametric magnet must be placed over on under the AS5050/AS5055 encoder, and should be centered on the middle of the package with a tolerance of 0.5mm.
The airgap between the magnet and the encoder casing should be maintained in the range 0.5mm~2mm.
The magnet holder must not be ferromagnetic. Materials as brass, copper, aluminum, stainless steel are the best choices to make this part.

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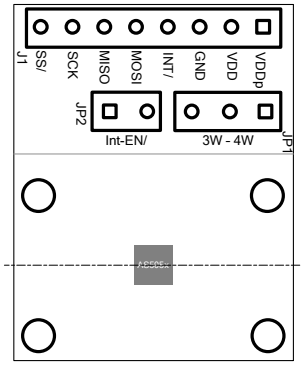
3 AS5050/AS5055 and adapter board pinout



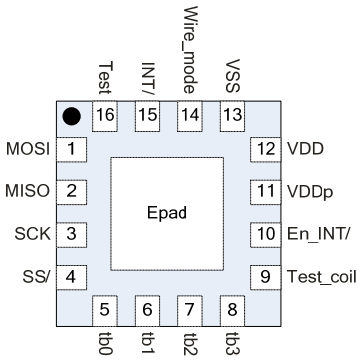


Figure 3: AS5050/AS5055 adapter board connectors and encoder pinout

Pin# Board	Pin# AS5050/ AS5055	Symbol Board	Type	Description
J1 - 1	7	VDDp	S	Peripheral power supply, 1.8V ~ VDD
J1 - 2	9	VDD	S	Analog and digital power supply, 3.0 ~ 3.6V
J1 - 3	10	GND	S	Supply ground
J1 - 4	11	INT/	DIO	Interrupt output. Active LOW, when conversion is finished
J1 - 5	15	MOSI	DI	SPI bus data input
J1 - 6	16	MISO	DO	SPI bus data output
J1 - 7	8	SCK	DI_PD	SPI Clock Schmitt trigger
J1 - 8	8	SS/	DI_PD	SPI Slave Select, active LOW
JP1	7	Wire_Mode	S	3 wire mode or 4 wire mode SPI communication
JP2	1	INT_EN/	DO_OD	Close: enable INT/ output Pin 1 is the AS505x En_INT/ input. Can be used for interrupt daisy chain (see chapter 4.3)

Table 1: Pin description

Pin types:	DO_OD	digital output open drain	S	supply pin
	DO	digital output	DI	digital input
	DI_PD	digital input pull-down	DO_T	digital output / tri-state
	DI_PU	digital input pull-up	ST	Schmitt-Trigger input

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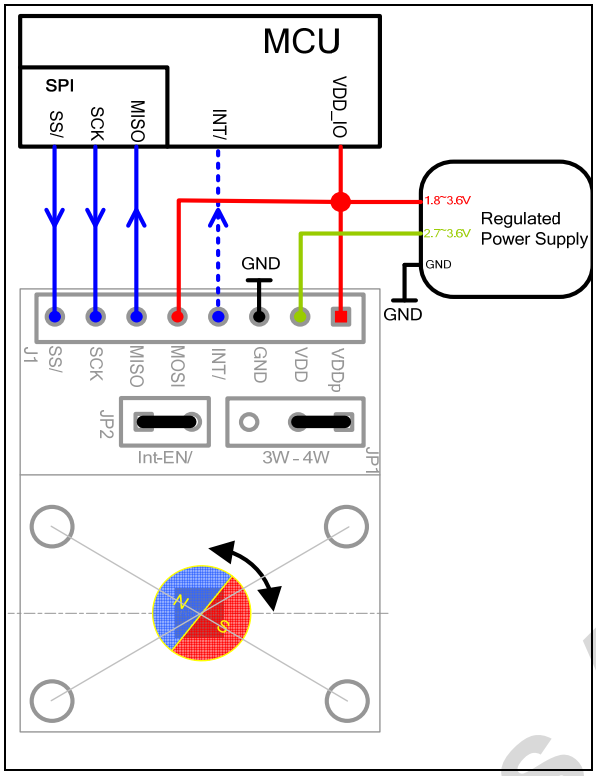
4 Operation use cases

4.1 One device SPI mode, unidirectional – 3 wire

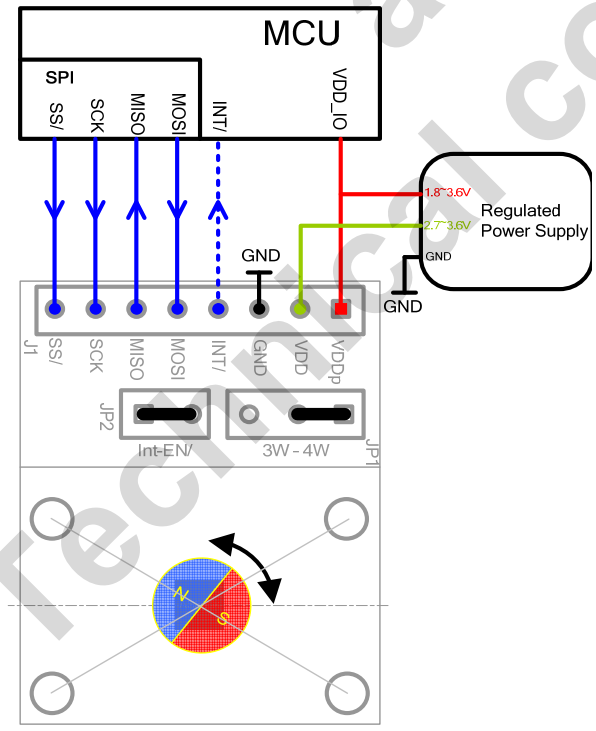


The AS5050-AB can be directly connected to an industry standard SPI port of a microcontroller. The minimum connection requirement for unidirectional communication (angle + alarm values reading) between the microcontroller and the AS5050/AS5055 are MISO, SCK, SS/.
The angle will be read at each 16-bit SPI transfer. See AS5050/AS5055 datasheet register table, register 3FFFh.

This value must be read with a period of 600µs or more in order to get a new angle position.

The INT/ signal can be attached o the microcontroller to indicate that a new angle position has been calculated.

4.2 One device SPI mode, bidirectional – 4 wire



If other registers than only angle value have to be read, or in order to write registers into the AS5050/AS5055, the signal MOSI is necessary.

The INT/ signal can be attached o the microcontroller to indicate that a new angle position has been calculated.

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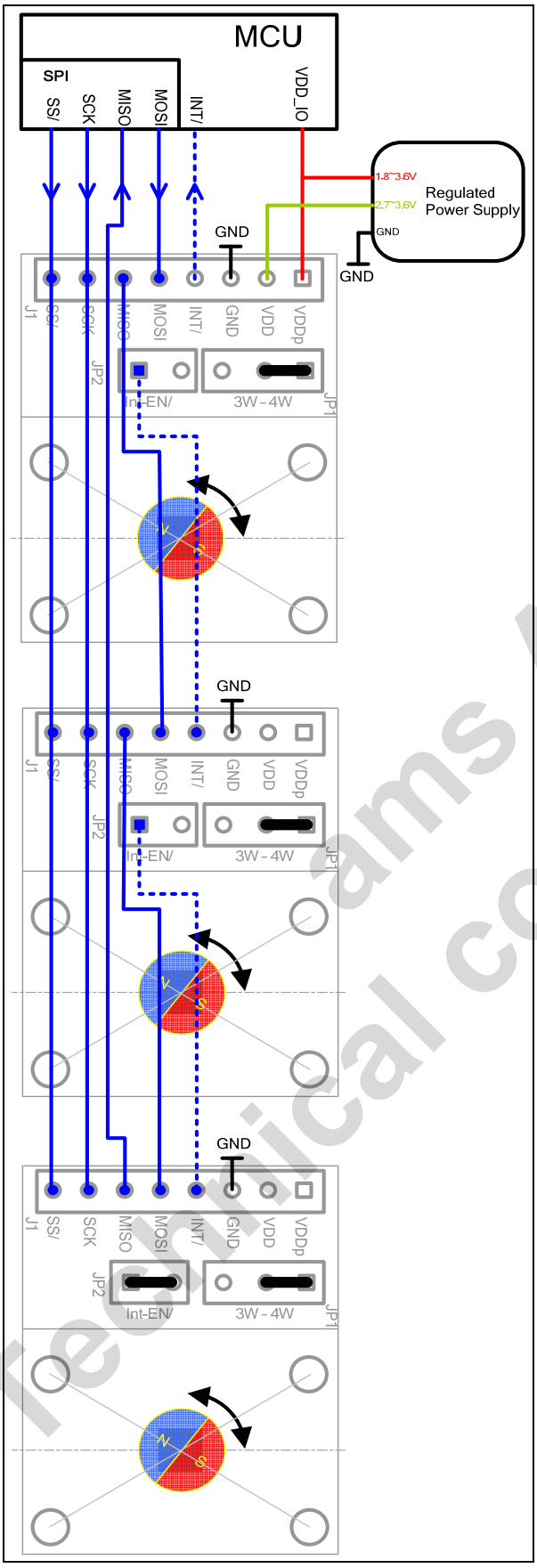
4.3 Multi devices SPI Daisy chain mode



The AS5050/AS5055 can be daisy chained, using 4 wires only for SPI communication.

In this configuration with n x encoders, the sequence will be processed as follow:
- MCU sets SS/ = 0
- MCU shifts n x 16-bit (e.g. READ command FFFFh) through the chain
- MCU sets SS/=1

At that point all the n x encoders have received the READ command FFFFh.
- MCU sets SS/=0
- MCU shifts n x 16-bit (e.g. NOP command 0000h)
- MCU sets SS/=1

At that point the n x 16-bit received on MISO are the n x angle values.

If an interrupt is needed, the signal INT/ can be daisy chained as shown on the diagram on the left. The final INT/ signal connected to the MCU will go LOW only if all the n x encoders INT/ = 0. The n x 16-bit angle readout can be performed here.

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5 Firmware coding

The following source code fits the 4-Wire application (chapter 4.2).
The function **`void spiReadData()`** `reads/writes 3 values from the AS5050/AS5055`
- Send command READ AGC / Receive value unknown
- Send command READ Angle / Receive value AGC
- Send command NOP (no operation) / Receive value ANGLE

If a READ ANGLE only is necessary in a loop, the procedure can be reduced to one line:
- Send command READ Angle / Receive value Angle (T-1)

The function **`static u8 spiCalcEvenParity(ushort value)`** is optional, it calculates the parity bit of the 16-bit SPI stream.

```
/*!
 ***************************************************************************
 *  Reads out chip data via SPI interface
 *
 *  This function is used to read out cordic value from chips supporting SPI
 *  interface.
 ***************************************************************************
 */
#define SPI_CMD_READ 0x8000     /*!< flag indicating read attempt when using SPI interface */
#define SPI_REG_DATA  0x7ffe    /*!< data register when using SPI */
#define SPI_REG_AGC   0x7ff0    /*!< agc register when using SPI */
#define SPI_REG_CLRERR 0x6700   /*!< clear error register when using SPI */

void spiReadData()
{
    u16 dat;                  // 16-bit data buffer for SPI communication
    ushort angle, agcreg;
    ubyte agc;
    ushort value;
    bit alarmHi, alarmLo;

    /* Send READ AGC command. Received data is thrown away: this data comes from the precedent
command (unknown)*/
    dat  = SPI_CMD_READ | SPI_REG_AGC;
    dat |= spiCalcEvenParity(dat);
    spiTransfer((u8*)&dat, sizeof(u16));

    /* Send READ ANGLE command. Received data is the AGC value, from the precedent command */
    dat  = SPI_CMD_READ | SPI_REG_DATA;
    dat |= spiCalcEvenParity(dat);
    spiTransfer((u8*)&dat, sizeof(u16));
    agcreg = dat;

    /* Send NOP command. Received data is the ANGLE value, from the precedent command */
    dat = 0x0000;      // NOP command.
    spiTransfer((u8*)&dat, sizeof(u16));
    angle = dat >> 2;

    }

    if (((dat >> 1) & 0x1) || ((agcreg >> 1) & 0x1))
    {
        /* error flag set - need to reset it */
        dat  = SPI_CMD_READ | SPI_REG_CLRERR;
        dat |= spiCalcEvenParity(dat);
        spiTransfer((u8*)&dat, sizeof(u16));
    }
    else
    {
        agc = (agcreg >> 2) & 0x3f;          // AGC value (0..63)
        value = (dat >> 2) & 0x3fff;         // Angle value (0..4095 for AS5055)
        angle = (value * 360) / 4095;        // Angle value in degree (0..359.9°)
        alarmLo = (dat >> 14) & 0x1;
        alarmHi = (dat >> 15) & 0x1;
    }
}
```

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```
/*!
 ****************************************************************************
 *  Calculate even parity of a 16 bit unsigned integer
 *
 *  This function is used by the SPI interface to calculate the even parity
 *  of the data which will be sent via SPI to the encoder.
 *
 *  \param[in] value : 16 bit unsigned integer whose parity shall be calculated
 *
 *  \return : Even parity
 *
 ****************************************************************************
 */
static u8 spiCalcEvenParity(ushort value)
{
    u8 cnt = 0;
    u8 i;

    for (i = 0; i < 16; i++)
    {
        if (value & 0x1)
        {
            cnt++;
        }
        value >>= 1;
    }
    return cnt & 0x1;
}
```

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6 AS5050 adapter board hardware

6.1 AS5050-AB-1.1 schematics

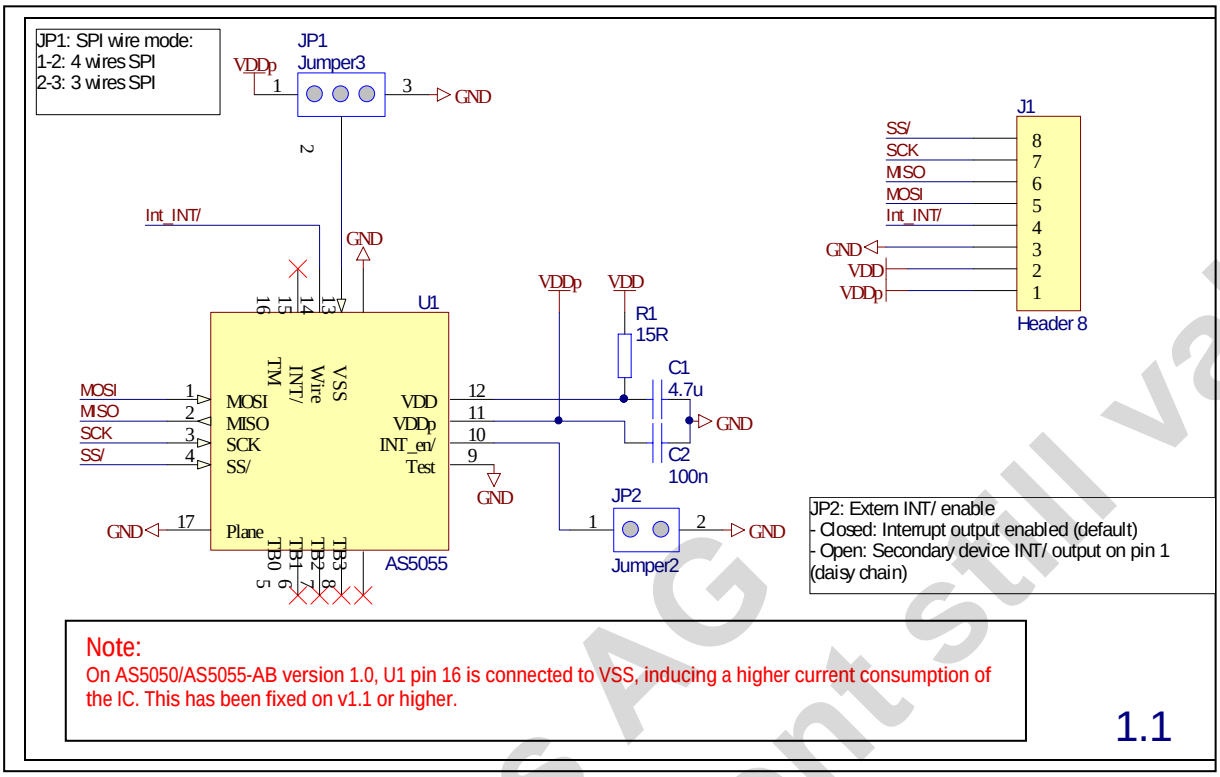

Figure 4: AS5050-AB-1.1 adapterboard schematics

6.2 AS5050-AB-1.1 PCB layout

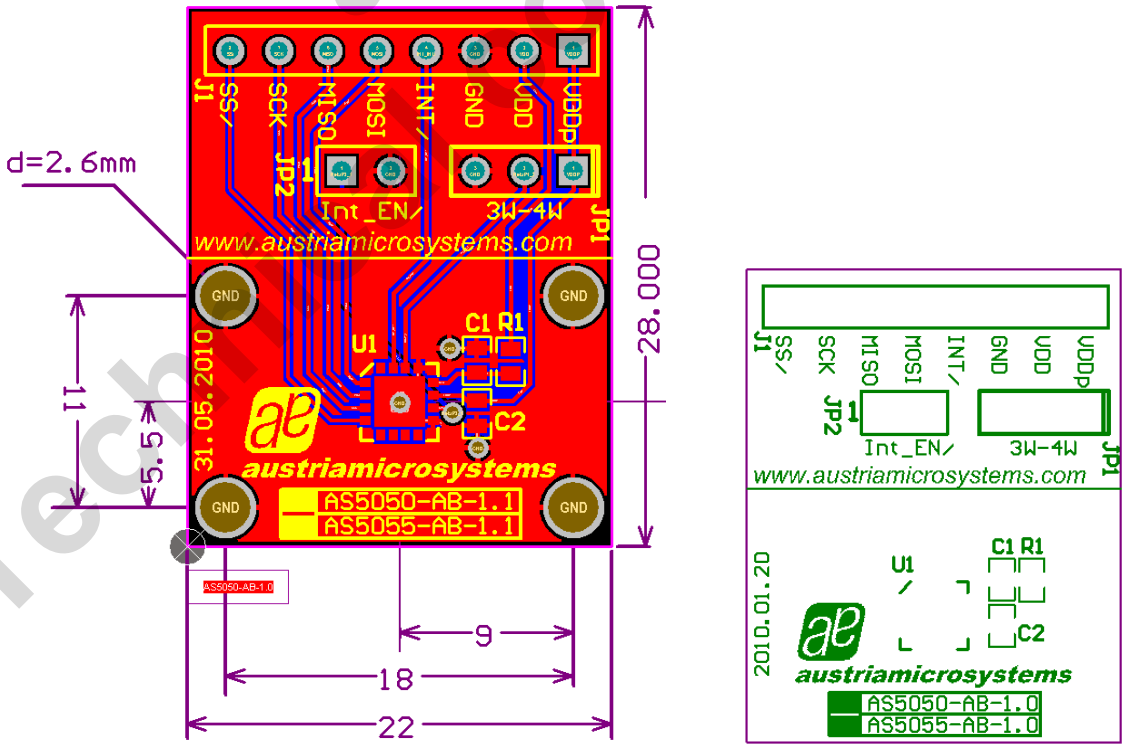

Figure 5: AS5050-AB-1.0 adapter board layout

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